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Research Problem Review   RPR 70-1

RESEARCH ON TACTICAL MILITARY DECISION MAKING:

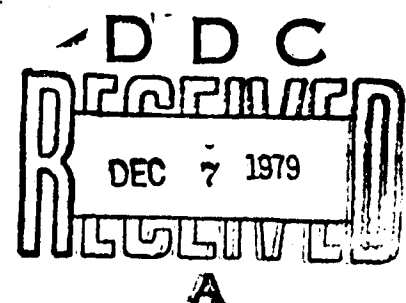# I. DESIGN OF A SIMULATED TACTICAL OPERATIONS SYSTEM (SIMTOS)

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An activity of the Chief, Research and Development

J. E. UHLANER
Director

Research Problem Review, RPR 70-1

RESEARCH ON TACTICAL MILITARY DECISION MAKING
I. DESIGN OF A SIMULATED TACTICAL OPERATIONS SYSTEM (SIMTOS)

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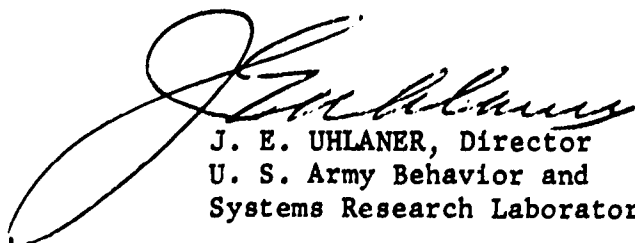Behavior and Systems
Research Laboratory

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FOREWORD

Technological advancements have led to increased speed, mobility, and destructive power of military operations. To permit commanders to make tactical decisions consistent with rapid change and succession of events, information on military operations must be processed and used more effectively than ever before. To meet this need, the Army is developing automated systems for receipt, processing, storage, retrieval, and display of different types and vast amounts of military data. There is a concomitant requirement for research to determine how human abilities can be utilized to enable the command information processing systems to function with maximum effectiveness.

This report is one of a series on the effectiveness of information transfer for selected display parameters. Companion reports in this series are "II. An Information Network Aid to Scenario Development" and "III. Predictor Variables and Criterion Measures." The reports establish the basis for the conduct of applied research concerned with information flow requirements in command information processing systems and with the establishment of information display standards.

The research effort was conducted by personnel of the Bunker-Ramo Corporation under the auspices of the BESRL Support Systems Research Division with Seymour Ringel as project monitor.

J. E. UHLANER, Director
U. S. Army Behavior and
Systems Research Laboratory

RESEARCH ON TACTICAL MILITARY DECISION MAKING: I. DESIGN OF A SIMULATED
TACTICAL OPERATIONS SYSTEM (SIMTOS)

BRIEF

Requirement:

    To provide plans for the phased development of a simulated tactical
operations system (SIMTOS) which will permit laboratory research on
tactical military decision making behavior, particularly with respect to
information flow and display variables.

Procedure:

    Conditions necessary for a realistic test facility environment,
scenario form and content, and testing practicalities were delineated.
On the basis of these, plans were outlined in brief for a sequence of
research phases designed to culminate in a capability to study decision
making behavior during free-play two-sided war games.

    SIMTOS capabilities currently available in BESRL to support the
research were examined and additional support capabilities needed were
identified. Details of the required physical facility are given.

Research Product:

    The product consists of the broad outlines of a six-phase research
plan designed to produce a simulated tactical operations system (SIMTOS)
for exercise within a simulated tactical operations center (SIMTOC).

Utilization of Product:

    Used as a vehicle for BESRL research within the SIMTOC, the SIMTOS
will constitute a realistic test environment for measurement of decision
making performance in command information processing systems.

RESEARCH ON TACTICAL MILITARY DECISION MAKING: I. DESIGN OF A SIMULATED
TACTICAL OPERATIONS SYSTEM (SIMTOS)

DEVELOPMENTAL SETTING FOR SIMTOS

The present report details plans for the design of an experimental
research facility, including hardware and computer software, within the
U. S. Army Behavior and Systems Research Laboratory. The program is in
the area of tactical operations systems and is concerned specifically
with the conduct of research on display and information flow in military
command and control systems. With the emphasis on tactical operations
systems, the automated system (TOS) developed for the Seventh U. S. Army
was used as the information system model to be simulated (SIMTOS). The
Tactical Operations Center (TOC) is used as the environmental model, and
the portion of the BESRL research facility devoted to experimentation in
this area is therefore termed SIMTOC.

The research is conducted by the COMMAND SYSTEMS program of BESRL.
The dual mission of the program is (1) to maximize effectiveness of
command information processing systems through the most efficient use of
human abilities and (2) to assist commanders and their staffs in the
critical functions of information assimilation and decision making within
the context of tactical military operations systems.

The mission of the COMMAND SYSTEMS program provided the general con-
text within which SIMTOS was developed. The evolutionary program envis-
aged is discussed in terms of the systematic accumulation of interrelated
research data that are needed to improve automated military information
systems. Detailed descriptions of the design of the SIMTOS information
system and the SIMTOC facility are presented as Appendixes A and B.
BESRL capabilities currently available to support the research program
are discussed, together with the additional hardware and software that
would be needed for such a program. Whenever possible, the plans call
for simulation of system capabilities. For research purposes, the need
for the many staff advisors who interact during the military decision
process can be eliminated through simulation. Their inclusion would
present formidable, and perhaps insurmountable, problems with respect to
laboratory space as well as experimental control. Simulation of the staff
advisor function is by computer software responsive to questions by the
decision maker. Similar considerations underlie the other simulation
procedures incorporated in the SIMTOC.

ARMY FIELD COMMAND

It is not the intention here to review the military command struc-
ture. However, there are some aspects of the structure and the function
of military units in the field directly relevant to the research issues
of importance and to the design of a research facility. These aspects
are basic to the rationale for the proposed sequence of experiments and

merit at least cursory attention. The following discussion focuses on the division, although it could apply equally well to corps or army command levels. The main reason for selecting the division for discussion is that, at the present time, it is the lowest echelon being equipped with an automated tactical operations system capability.

The nerve center of tactical activities during field operations is the Division Tactical Operations Center (DTOC). (At corps level this is referred to as the CTOC and at field army level, as the FATOC.) The DTOC is intended to be composed of only those staff elements which are directly concerned with the combat situation. The reasons for this are apparent. The combat center, if small, will be more difficult for the enemy to locate and will be more able to move rapidly to keep in close communications contact with its subordinate units. The staff elements represented in the DTOC are at the discretion of the commander but will normally include the following: Intelligence, Operations, Fire Support Coordination, Air Liaison, Engineers, and the Chemical, Biological, Radiological Element. The general staff elements of Personnel, Logistics, and Civil Affairs are not usually represented in the DTOC but are nearby at main headquarters, as are most of the special staff elements. The DTOC staff elements are duplicated at an alternate combat center which provides backup to the DTOC and assumes control during displacement or neutralization of the DTOC.

The DTOC is linked to headquarters and combat unit command posts by a variety of communications media: teletype, radio, telephone, and messengers. Within the DTOC, intercoms may be used for coordination of information, but primary reliance is placed on messengers and on central displays which are periodically updated.

The conduct of the combat activities is the direct responsibility of G3 Operations. In terms of the commander's guidance and within the limits of his assigned responsibility, it is the G3's decisions which control combat units' activities.

The division commander and his two assistant division commanders are briefed twice daily at the DTOC. Although they are in continual radio contact with the DTOC at other times, most of their day is spent in face-to-face contact with senior commanders and with commanders of subordinate units.

The point to recognize is that the realistic study of a commander's decisions requires that the conditions under which his decisions are made should somehow be duplicated or simulated in the laboratory. In practice, the commander is receiving new information from a variety of sources over a period of time, and time is available for him to assimilate information and to discuss potential courses of action with his staff, with subordinate unit commanders, and with senior commanders.

The purpose of automated system data within the DTOC should not be primarily to aid the commander's decisions. The commander is seldom there, and when he is, he confers with his staff. The displays are

probably more appropriately oriented to the needs of the G3. This orien-
tation cannot, however, exclude consideration of the specific information
display needs of the other staff elements in the DTOC who would also use
an automated system's capabilities. In fact, the several automated systems
currently under development for tactical use are designed primarily to
satisfy the needs of all the general staff and many of the special staff
elements. The Tactical Operations System (TOS) is designed to aid in
combat operations and emphasizes intelligence and operations information.
The Tactical Fire Control System (TACFIRE) assists in the combat effort
by merging intelligence, targeting, and artillery data to improve fire
direction. The Combat Service Support System is yet a third automated
system which deals with personnel, logistics, civil affairs, finance,
medical, military police, and other special staff element information.

Although these military information systems are designed to serve
particular staff elements, they may aid the commander in at least two
respects. First, if staff performance is enhanced, command performance
may benefit. (This is not an inevitable result but certainly the con-
verse is true: Degraded staff performance will limit a commander's
effectiveness.) Second, automated information systems can summarize
information or can screen out the highly detailed data needed by the
staff elements so that the commander can be presented with timely and
relevant information during his twice-daily briefings. These data could
also be presented by means of computer-driven displays which may also
have a beneficial influence on the commander's briefings. The problems
in this regard, which are further considerded in subsequent portions
of this publication, concern the categories of information which should
be displayed, and to what level of detail.

GENERAL CAPABILITIES OF AUTOMATED INFORMATION SYSTEMS

The categories of data handled by the several automated military
information systems vary considerably. However, there is a limited
number of potentially advantageous information processing capabilities
which all the systems possess. If the research intention is to study
generalized DTOC display requirements and design, it is more important
to include in the research design all the information processing capa-
bilities that can be provided by an automated system than to attempt to
include all possible categories of data.

The most elemental capability the automated system provides is for
the rapid and secure communications among system subscribers. Related
to this is the capability of transmitting data simultaneously to several
geographically separated users (message switching). The computer auto-
matically routes messages, and automatic encryption/decryption equipment
in the system provides for the secure transmission of information.

A second feature provided by an automated system of relevance to
military staff needs is that of rapidly retrieving information from a
voluminous data store. Given that data have been entered into the system

as the designers intended, data relevant to a variety of problems and decision situations can be retrieved in an extremely brief time. This retrieval can be in terms of a single item of information or in terms of information from several computer files that satisfies fairly involved data correlation requirements. (Examples of these might be "Give me the CP location of the second brigade," and "Give me the CP locations of all units of battalion size or larger which may be within a particular fallout pattern for a period of six hours or more.")

The automated systems can also provide assistance to the military user by preparing reports periodically which summarize current status. This report preparation capability can be automatic or it can be accomplished on demand. The reports represent compilation and formatting operations on continually updated information within the data base, and may be regarded as a special case of the data retrieval capability noted above.

The duties of some military staff elements require the computation of fairly complex formulas--a capability well suited to automation. Use of this capability is, however, restricted to those few staff elements for which it is appropriate. Therefore, if the research intent is to assess information flow, or automated system capabilities in improving information flow, care must be taken to include problem situations involving these particular staff elements and their peculiar data processing needs.

Finally, automated systems provide a capability for automatic dissemination of data. The first capability noted above--communication among system subscribers--referred to a message switching capability which enables a user to send messages simultaneously to several addressees. Reference now is to the capability for a subscriber to store a Standing Request for Information. This request is stored in the computer for a period of time designated by the subscriber. All data that satisfy the standards established by the subscriber are automatically routed to him. This capability minimizes, of course, his need to ask for data. Moreover, it can permit him to request the categories of information he is personally interested in, and at the level of specificity he desires.

SYSTEM APPLICATIONS TO DTOC ENVIRONMENT

Attention now turns to specific applications of the capabilities afforded by automated systems in terms of the duties of the staff elements in the TOS which constitute the environment to be simulated in the proposed SIMTOC facility. The capabilities noted in the previous section are the computer software features which need ultimately to be simulated. The topics discussed here establish the necessary contents of scenarios (data files) to be developed if it is desired to explore realistic problem situations.

The three automated systems do not interface at the present time, although each will ultimately be represented in the DTOC. The problems involved in effecting such an interface are of considerable research importance, and some of these also are amenable to study in the proposed SIMTOC facility.

The categories of information in the Seventh U. S. Army TOS deal with:

Friendly Unit Information
Enemy Situation
Enemy Order of Battle
Nuclear Strike Effects
Nuclear Fire Support

TOS development plans call for the addition of other functional capabilities. By the 1975 time frame, it is intended that the following additional categories be operational:

Tactical Gap Crossing Status
Airfield/Heliport Location and Status
Tactical Troop Movement
Weather Data
Terrain Intelligence
Army Air Operations
Air Space Coordination
Air Defense Information
Barrier and Denial Plan and Status
Chemical Contamination
Electronic Warfare
Target Intelligence
Counterintelligence
Tactical Air Support: Close Air Support
Tactical Air Support: MATS Air Movements
Communications Planning
Internal Defense and Internal Development Operations
Hostile Air Defense
Strategic Intelligence
Intelligence Collection Management

These TOS capabilities are to be supplemented by the TACFIRE system (which will by that time have absorbed the Nuclear Fire Control capability listed above) and by the Combat Services Support System (CS_3).

The CS_3 will include the following functional area capabilities:

Casualty Reporting
Civil Affairs
Combat Service Support Administration
Communication Directory Service
Construction
Financial Accounting and Control

Frequency Assignment and Allocation
Graves Registration
Maintenance
Materiel Status
Medical Services
Military Pay
Military Police Services
Personnel Management
Personnel Status
Read Area Security and Area Damage Control
Supply
Transportation Service

Not all the above CS_3 categories of information directly serve the
DTOC staff elements. Most were designed to serve the headquarters staff.
However, the effective conduct of tactical operations frequently requires
that information within these categories be obtainable by the operations
staff element. Consequently, it can be envisioned that, as a minimum, a
capability will be provided within the DTOC to extract relevant informa-
tion from the CS_3 data base.

This consideration is important because the present research emphasis
is on developing a SIMTOS, with a simulated capability or duplicating TOS
functional areas. But decision situations often require for their solu-
tion data which will be available in the TACFIRE, the CS_3, and other mili-
tary information systems such as the Intelligence Data Handling System.
A companion report in the current series discusses an information network
aid to the development of test scenarios.[1] This network document graphi-
cally illustrates the coordination requirements on the part of various
staff elements during a tactical decision making situation.

DEVELOPMENT OF SIMTOS

THE DECISION MAKING PROCESS

During design and development of the Seventh U. S. Army Tactical
Operations System, a list of eighteen major command decisions was prepared.
This list, which summarized the opinions of senior staff officers within
Seventh Army, identifies decision situations which may confront commanders
in the event of Seventh Army tactical activity. The list includes com-
mitting a reserve unit, launching a counterattack, changing the mission
of a maneuver unit, mounting a nuclear offensive, and initiating a river
crossing.

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[1] Ryan, T. G. (The Bunker-Ramo Corporation). Studies of tactical mili-
tary decision making: II. An information network aid to scenario
development. BESRL Research Study 69-11. September 1969.

Each decision situation requires for its solution the extraction of relevant information from a variety of categories serving continuing requirements of the G2 and G3 staff elements and several special staff elements. At present, this information is obtained from the various staff elements by face-to-face or telephone communication. In the future, it may be obtained by querying the automated system data base during the decision making process.

As used herein, the term "decision" refers to the complete process that begins with a commander's recognition that a problem exists and generally culminates in one or more orders or directives intended to resolve the problem. The term "decision situation" refers collectively to the mission assigned to the commander, the number and types of military units he commands, the displays in his tactical operations center, and the messages which are input to establish a specific problem in the test setting.

A crucial issue in the conduct of studies of military decision making, and one that has guided the views expressed here, is the conceptualization of "decision" as a sequence of observable actions which are amenable to objective measurement.

The point is important in that the convenience of the word "decision" masks a host of practical measurement considerations. Among these considerations is that, in a practical sense, there really is no single measurable entity constituting "a decision." Rather, the term "decision" refers to a process which consists of a substantial number of identifiable steps. For specific situations, specific persons, and specific reaction time requirements, many of the steps may be compressed, or may even be omitted entirely. However, in the general case at least, the following may be identified:

1. Detecting or "sensing" a change in a situation.

2. Hypothesizing possible significance of the detected change (e.g., threat evaluation--does the change represent a feint or an actual attack?).

3. Defining the scope of the problem by initiating requests for additional information or for verifying existing information.

4. Consideration of whether remedial action is required, and to what extent.

5. If remedial action is deemed to be required, consideration of alternative actions in order to select the most appropriate response.

6. Consideration of resources that can be made available to support each possible alternative action.

7. Selection of most appropriate course of action to cope with the changing situation as it is defined or understood.

8. Hypothesizing contingencies that could disrupt the selection action.

9. Consideration of relative probabilities of occurrence of each contingency.

10. Consideration of relative seriousness of each contingency for both tactical and strategic postures.

11. Evaluating resources that could be made available in time to meet potential contingencies.

12. Selecting appropriate counterthreat responses for at least the most probable contingencies, and mobilizing available resources to prepare for counterthreat responses (alerting or moving reserves, requisitioning additional troops or materiel).

13. Implementation of selected action by the issuance of clear directives (the "decision," as commonly understood) and advisory messages, as appropriate, to inform superior, adjacent, and subordinate units of plans.

Many of the above steps in the decision process may, in a military command situation, be accomplished by more than one person, thus complicating evaluation of the process. Change detection, for example, may occur at a low command echelon where an enemy action impacts, or it may occur at a high echelon which is synthesizing partial inputs from many subordinate sources. Problem definition and the consideration of alternative actions may be accomplished by staff studies over extended time periods, or they may, in urgent situations, be accomplished rapidly by the commander himself, based upon his background knowledge and personality characteristics. Or they may be ignored.

If the decision situation selected for study would normally require analysis of contingencies and staff study support, the displays and the test scenario must be developed accordingly. There is an intimate relationship between the definition of the decision process and the identification of detailed information requirements. This point has relevance to the development of scenarios. If the required information is situation-specific, then a variety of situations must be tested before generalizations can be made concerning information needs and forms of display.

RESEARCH CONSIDERATIONS

The background information presented above indicates the complex problems attached to the realistic structuring of military decision-making research. In the interest of practicality, some tradeoffs are

required. Accommodation must be made to simulate the TOC work area and the normal staff coordination as well as to prepare a data base and a series of data input messages to simulate a combat situation.

In addition to the problems discussed, there are other issues which must be resolved before controlled experiments can successfully be accomplished. These issues are relevant to the subsequent section which suggests a research sequence of expanding capability.

Experimental Control Issues. The most difficult issue in research on military decision making is the criterion problem. Even if a realistic scenario has been developed and issues of staff participation have been solved, the problem remains of how to evaluate the quality of the decisions that are made. A number of techniques are possible but research time is required to evaluate each technique and to select for the experiment the methods that yield the most reliable measures.

A second problem is the preparation of a test scenario for a situation in which the decision maker is supported by staff representatives. Any scenario is, of course, a contrived situation. But a test scenario involving a staff complement should not be obviously contrived. In other words, group problem-solving behavior should be elicited because a realistic problem is detected and properly defined, as should normally occur in a TOC. Scenario materials should occupy the staff in normal staff duties and the problem which emerges should ultimately involve the collective knowledge and skills of the staff. Such an intricate scenario, involving message content, message format, and careful timing, requires substantial developmental time.

Related to these scenario development issues is the problem of how to control the action. The decision situation develops over some period of time, and subsidiary decisions may be made during this time that alter the appropriateness of the planned injection messages, particularly if multiple subjects are used or if a two-sided war game is played. It is unlikely that the decision makers will respond entirely in accord with the planned scenario, and the experimenter team must plan for such deviations during development of the test. A free-play war game is interesting to watch and this type of exercise may be an effective training method, but it is unlikely to yield useful test results. Provisions must be made for periodic commander's guidance to assure that the subjects remain within the bounds of the problem. Alternatively, provision must be made for highly experienced military experts to act as exercise controllers and to respond appropriately to the deviations. In other words, either the experimenters control the test or the subjects determine the course of events, not both.

A final control issue concerns the composition of the subject team when multiple subjects (commander and staff) are used. Anticipated inter-subject skill variability must be taken into account in the data analysis. Such an analysis would reveal possible interactions such as between level of staff performance and type of information display.

Experimenter Capability Issues. An obvious consideration is that display equipment, input/output devices, and the computer hardware and software must be available to support the desired level of effort. Not so obvious is the fact that the development of the necessarily flexible computer program may require a considerable period of time. Therefore, such programming development activities must precede, by a considerable amount, the anticipated start of projects involving multiple subjects. The programs must be flexible to accommodate experimenter learning as the studies progress.

Experimenter sophistication increases with experience in this type of testing. New knowledge of military tactics, obtained as each new subject contributes something from his unique experiences, may suggest desirable changes in the scenario. New ideas arise concerning ways of scoring. These may introduce changes in computer software subroutines to record or score subject responses, and new events arise (such as a scheduled subject's failing to appear) that may suggest changes in the testing procedure. These issues are inevitable, but their impact will be less if they are resolved during early experiments in the sequence when individual subjects are being tested using relatively uncomplicated scenarios.

A final consideration in this category is the availability of test subjects. The nature of command/control research requires that these be at least field grade military officers. Further requirements include formal command training and at least some field experience in the type of military unit covered in the scenario. (An officer whose career had been in airborne units would be an inappropriate test subject to act as G3 of an armored division.) Suitable test subjects are difficult to locate and, if they are on active military duty, even more difficult to rely on for a particular test session. Therefore, provisions must be made to avoid aborting an entire test involving multiple subjects in the event one of the subjects cancels his appointment at the eleventh hour. (Similar contingency plans are, of course, necessary in the event of computer failure during a test session.)

Staff Testing Research Issues. If the test situation involves the use of subjects to serve as general staff officers, consideration must be given to the development of subject procedures. The interest is in measuring decision-making behavior, and this measurement should not be impaired by learning curves for equipment operation. The test schedule will be stringent, not permitting extensive training sessions to famil-iarize the subjects fully with the data base, the information system capabilities, and the equipment operation. The research team may not be sufficiently large to serve as "assistants" to the subjects. It will then be necessary to determine the optimum input message formats for the subjects to use to request various data from the computer or to transmit a message to other subject stations. Also, attention must be given to the optimum formats for staff element glossaries indicating categories of information available in the data base. These issues may need to be re-solved by experimentation--yet another factor in determining the suggested sequence of research projects.

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Commander Testing Research Issues. In addition to the foregoing problems that may be at least partially resolved during the testing of individual subjects, there are a number of issues concerning scenario content which can be resolved in these preliminary explorations--categories of information which should be available for display at given subject stations, categories which can be anticipated in the event the subject requests additional data, levels of detail to be provided within each category of information, and display formats and display modes for presenting the data to the subject. These conditions can form the independent variables for several experiments.

Resolution of the above issues can be expected to have an impact upon subsequent military information systems in a number of areas. One area concerns the nature of information which should be continually displayed in future TOCs and the nature of information which should be available (and in what form) in the data base to be provided on request. Answers to questions such as these will have an impact on software design in terms of influencing file structure, operating system, and special process routines.

PLANNED PHASES IN SIMTOS DEVELOPMENT

A progression of research phases on tactical military decision-making behavior, based on the foregoing considerations, has been delineated. The six phases represent increasing levels of research complexity.

Phase I: Static Scenario

The scope of the research effort in this phase would be to prepare a "static" scenario (i.e., non-combat), to develop a criterion measure of performance, and to test for possible relationships between measures of decision making behavior and decision quality. Subjects would be tested individually, with the experimenter serving as the subject's computer operator "assistant."

Anticipated outcomes of this phase are as follows:

1. A scenario available for use in subsequent phases to familiarize the decision maker with the composition and location of his forces and with the events leading up to the combat situation.

2. Determination whether reliable objective scoring standards can be developed to measure decision quality.

3. Hypotheses concerning possible relationships between the decision making behavior and decision quality.

4. Information relevant to subject selection standards.

5. Rudimentary routines for accessing the computer data base on-line with other experiments without mutual interference.

6. Collection of preliminary data concerning techniques of scenario development.

Phase II: Limited Combat Scenario

During this phase, the above scenario will be expanded to include the first few hours of combat. Additionally, the decision scoring and decision process scoring techniques developed in the first phase on a defensive planning task will be checked in terms of an offensive planning task (by asking some subjects to play the role of the enemy operations officer). The hypotheses concerning relation of decision making behavior to decision quality will be tested. Finally, the Phase I work will be consolidated by revising display formats, eliminating non-relevant information from the data base, adding data to satisfy requests made by Phase I test subjects, and revising the data base glossary.

Anticipated outcomes of this phase are as follows:

1. The basic software will be available to support scenarios dealing with combat type situations wherein spot reports are intermittently received from simulated front-line units and periodic reports and advisories are received which alter the perceived situation.

2. The software will be expanded to include automatic recording of subject's requests for data.

3. Problems involving a subject's operating the system (training required, glossary format) will be resolved, thus contributing to subsequent phase testing procedures.

4. The hypothesis concerning relationships between decision making behavior and decision quality will be tested and, if verified, will contribute to procedures for scoring during multiple subject tests.

5. Techniques for developing scenarios will be checked for their comprehensiveness, thus facilitating development of materials for subsequent phases.

6. Additional data will be obtained concerning categories of information and levels of information detail requested by the subjects.

Phase III: Limited Two Sided War Game

The concepts developed in the earlier phases will be tested. Also during this phase, tests of display variables will be initiated. Two subjects will be tested simultaneously, playing the roles of opposing operations officers. The Phase II scenario will be employed essentially in its developed form. The subjects will access their own data bases, with each subject's actions influencing the data presented to the other. As independent variables, the display formats presented to the two subjects may differ for the two subjects.

Anticipated outcomes of this phase are as follows:

1. Confirmation of scenario contents, glossary format, subject procedures, scoring procedures, and software suitability.

2. Experimenter experience in controlling the action sequence in a two-sided war game, and in developing or modifying procedures for selecting and scheduling test subjects.

3. Experimental data concerning relations of such independent variables as display format, information detail, or information timeliness to decision making process scores and decision quality scores.

Phase IV: Echelon Information Flow

The preceding phases will most probably be conducted simulating a single TOC environment. By Phase IV, the research facility, experimental methods, equipment, and software should be sufficient to expand the research to the study of information flow among several echelons, a prelude to more comprehensive war game studies. The research at this point would also initiate contributions to developing military information systems concerning echelon information needs, software file contents, and data filtering capabilities.

The intention would be to have as many as three subjects being tested simultaneously on the same scenario and assigned to the same staff element but at three echelons. Thus, one set might be battalion S2, brigade S2, and division G2. Another set might be comprised of brigade S3, division G3, and corps G3.

Input message traffic would be fairly high so that the subjects would have to decide what information should be entered in the data base (for access by other echelons). Queries would be initiated by each echelon to satisfy their particular local task assignments.

Anticipated outcomes of this phase are as follows:

1. Data would be obtained concerning the amount of training required, optimum formats on which to prepare data input messages, and the extent of information filtering which might be expected as a function of input echelon and workload.

2. Data would be obtained concerning information category and specificity requirements as a function of command echelon.

Phase V: Staff Element Coordination

During this phase, the research would be extended to explore staff element interactions during the decision-making process. Several subjects would be tested simultaneously acting, for example, as division commander, G2, and G3 at a DTOC. The subjects would communicate with each other and with the data base using only the input/output devices. Essentially the same scenario as was used previously would be employed.

Anticipated outcomes of this phase are as follows:

1. Research methodology and scoring procedures for staff element interactions would be developed.

2. Experience would be gained in controlling, scoring, and analyzing highly variable interactions during this type of group problem solving.

3. Data would be collected concerning information needs of a specific staff element (with respect to other elements' outputs).

Phase VI: Free Play, Two-Sided Multi-Level War Game

By the time the preceding phases have been accomplished, sufficient capability should exist to conduct meaningful objective research on the decision process in a simulated combat environment. The expertise should exist to study commander and limited staff interactions simultaneously at two command echelons for two opposing forces. Testing realities might limit such research to several staff elements of two opposing echelons. The suggested procedure is to begin with the Phase I scenario so that the respective commanders and staffs (consisting of at least the G3, the G2, and one special staff element representative) could familiarize themselves with the tactical situation. Free play would commence with an attack order. Scoring would proceed along lines established in Phase V. Scenario preparation and controller actions would be guided by results of Phase IV and Phase II, respectively. The independent variables would be guided by Phase III and Phase IV results, and the subject training and operating procedures would be guided by knowledge obtained during all the five phases.

The following is the anticipated outcome of this phase (depending on the particular set of independent variables selected for the various studies):

Results concerning the impact upon tactical military decision-making behavior of such variables as: command echelon, staff composition, staff training, staff interaction patterns, commander and staff element display variables, commander and staff element information specificity requirements, and influences of information quality (accuracy, completeness, timeliness).

PROCEDURAL CONSIDERATIONS

The phased approach to developing SIMTOS requires that each successive phase be capable of building on the experience gained in previous phases and be responsive to new or changing objectives in BESRL experimentation. SIMTOS software must therefore be modular so that software routines developed in the initial phases can be used in later phases.

SIMTOS AS A TEST BED

During Phase I research, a subject representing, say, a general staff officer will enter an area representing a staff element section of SIMTOC, where various display equipment is installed. An experimenter will present an overall mission objective which the test subject is to accomplish in a hypothetical tactical military situation. When the subject is ready to begin the exercise, the experimenter will enter a message using a CRT device to signify to the computer that a testing exercise has started. The subject may direct questions to the experimenter (who will represent other staff elements) concerning terrain features, intelligence summaries, troop strength, etc. The experimenter will scan a list of available information and enter a corresponding code on the display device. The computer will display the data directly on the display device, type it on a typewriter, or instruct the random access slide projector to display the desired information. When the subject has indicated the action he has decided to take, the experimenter will sign him off on the device.

During Phase II and later phases, the subject will access the data base directly, without intervention by the experimenter. The procedures will be sufficiently direct to permit such accession with a minimum of subject training. The experimenter will still have to sign on and sign off, but his participation during the war game will probably be restricted to monitoring the subject's activities.

Before SIMTOS software can be made available even for such limited test exercises, a suitable data base will have to be prepared for on-line storage, appropriate formats will have to be designed, and extensive checking and adjustment performed to insure the proper effect of the data

base presentation. SIMTOS software will incorporate a pre-processor phase in which experimenters will describe formats and input data. The resulting data base will exist on a disk pack and on slides. The disk pack will be placed on-line at the beginning of a testing exercise and used as often as required.

After a testing exercise has been completed, the SIMTOS software will have collected data as prescribed by the experimenter staff. These data will be stored on either disk or tape so that they can be produced at a later time. The data will contain a history of the computer-experimenter communication that occurred during the exercise, including the subject's name, identification of the input/output device location (duty station), exercise number, time signed on, time each information request occurred, data displayed, type of display device used, duration of the information display, and time signed off. This information could be held over a period of time and produced in a report as needed. Depending on the requirements of the experimenting staff, data could be obtained on groups of exercises as well as on individual experiments.

SYSTEM CAPABILITIES REQUIRED

The major capability to be included in the SIMTOS will be the ability to retrieve data via the CRT display device from an on-line data base. SIMTOS software will allow one of two methods of data retrieval to be utilized during a testing exercise. In one method, an index including data codes is displayed on the CRT. The experimenter (or subject) specifies the category of data desired by entering the appropriate data code. A subordinate index retrieval level could also be incorporated so that information from the data base could be extracted via specific data retrieval paths. An alternative method of data retrieval might be similar to the method used in the TOS. Format designators are extracted from glossaries and typed in, along with the specific key field. The retrieved information is then displayed on the screen.

Implicit in a data retrieval capability is a method of storing data on disk in an orderly manner so that the information can be appropriately retrieved. SIMTOS software will accept from an experimenter (in punched-card form) sign-on formats, index formats, retrieval message formats, retrieval message contents, relationships between index and retrieval messages, etc., and will assemble the data on disk into a meaningful data base to be used in a testing exercise. The experimenter will have almost complete freedom in selecting formats, indexing arrangements, designating position of the data entry marker on the CRT, etc. Thus, the potential will exist to evaluate the effectiveness of various formatting and data display methods. A third capability that must be included in the initial software package is statistical reporting capability. Although the role of this capability will be expanded significantly in future SIMTOS software, the initial phase will be limited to providing a message history report as described above.

These capabilities, and their corresponding human activities, are indicated in Figure 1, which illustrates SIMTOS da'.a flow for the initial research phase.

THE SOFTWARE PACKAGE

The SIMTOS software package will b. composed of three subsystems: the pre-processing subsystem, the on-line testing subsystem, and the statistical reporting subsystem.

The purpose of the pre-processor subsystem will be to prepare an on-line data base for the on-line testing subsystem. The experimenter personnel will design formats and create data base information and prepare the information on punched cards in a prescribed manner. The pre-processor will receive the cards, edit them, and store their contents appropriately on a disk pack. A disk pack update capability will be available so that data bases can be developed in installments. The output of the pre-processor subsystem will include the desired data base stored on a removable disk pack, an audit list of new input data and, on demand, a list of all message formats contained on a given disk pack.

The on-line testing subsystem will provide computer assistance during testing. The experimenter will assure that the proper disk pack is loaded and the program is in computer memory before a testing series begins. The first action of this subsystem will be to display the designated start-of-test format on the CRT. When the experimenter fills in any appropriate field and presses the "send" button, the program will save the message and record the time. At that point, the system will either display a designated format or allow the experimenter to type in a format code. Every time the experimenter presses the "send" button, the computer will interpret the request, edit the request, log the time of the request, save the request contents, and respond to the request. When the experimenter signals that the test is completed, the system will display the sign-off message (if necessary), save any sign-off contents, and ultimately display the sign-on format for any new subject.

The purpose of the statistical reporting subsystem is to provide a system log to support subsequent statistical analyses. The input data will exist on disk or tape. A given output statistics run will handle reports from one or many exercises and will treat each report separately. For an exercise, the sign-on format will appear first showing the time the message was received by the computer. Messages sent to or from the computer will be printed in order of occurrence. After the sign-off message, a summary of the events will be printed.

FUTURE CAPABILITIES

A few of the capabilities which may be included in a possible expansion of SIMTOS software are indicated below.
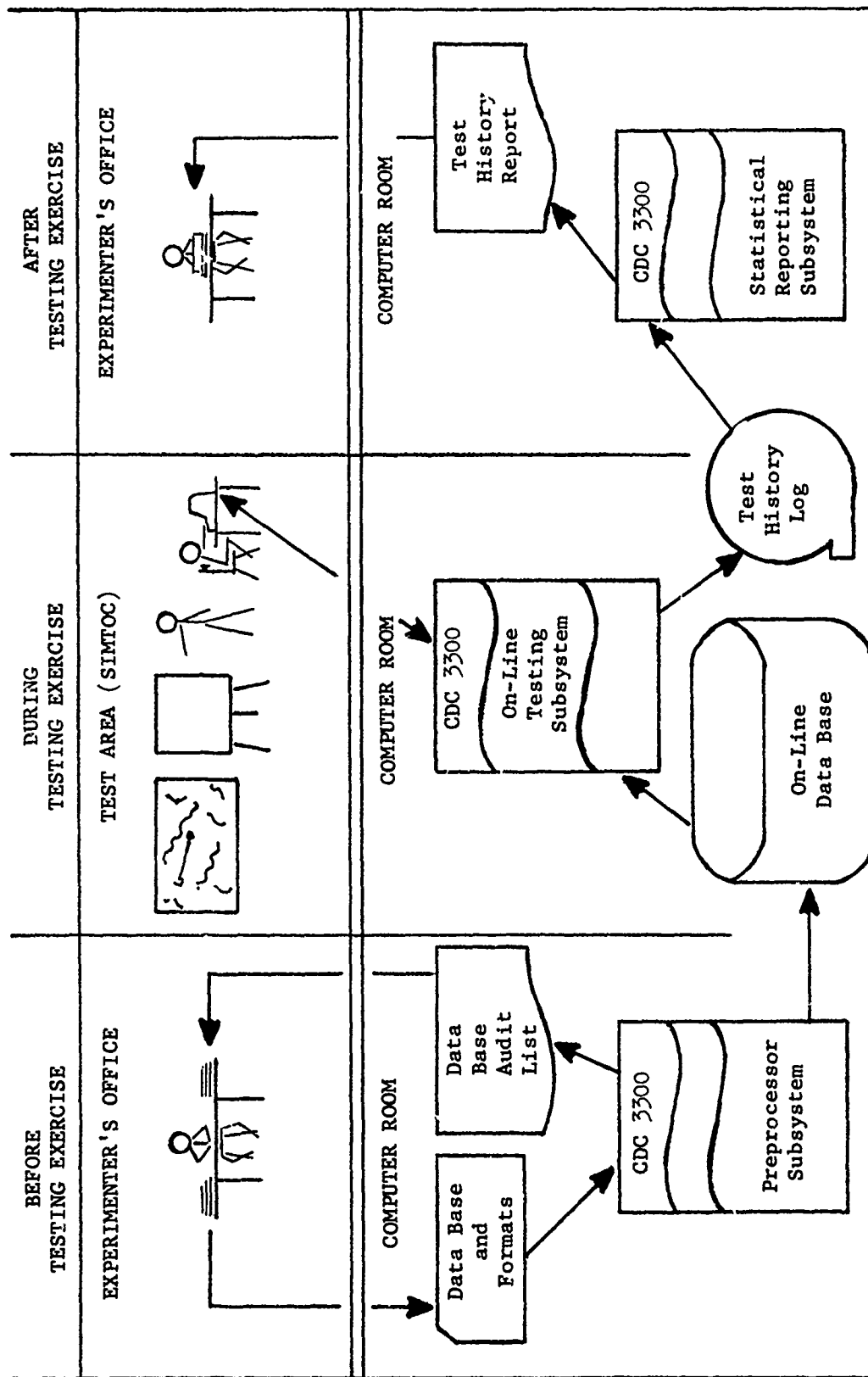
Figure 1. SIMTOS Data Flow--Initial Phase

In the initial phase of SIMIOS as planned, only ore CRT display device can be used at any one time. It will be advantageous in future testing to allow several subjects to participate at the same time, time-sharing the computer with each other as well as with a batch processing operation.

As the tactical decision making testing becomes more sophisticated, it will be necessary that the experimenter or the subject be able to alter the data base during the testing. Also, it would be beneficial to allow separate display messages to be interrelated so that an adjustment to the contents of one display message will affect the contents of related display messages. Another feature quite similar to the capability of updating the data base from the display device is the capability of allowing the experimenter to use a programmed keyboard for dynamic changing of large portions of the initial data base, perhaps in response to or as the result of subject action. The data base would be restored to its initial form when the subject has signed off.

The initial phase is considered to use the display device, the selectric typewriter, and the random access slide projector (RASP) during on-line testing subsystem operation. It might be beneficial during future testing to allow messages to be displayed on the IBM-1052 typewriter, on a high-speed printer, or on a scribing projector.

Future plans in the testing of tactical decision making indicate that different subjects will interact with each other as members of a simulated Army staff supporting a commander, or as opposing force commanders in a simulated conflict. These environments, from a computer software standpoint, could vary considerably. Each variant would be likely to require additional capabilities.

APPENDIXES
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APPENDIX A   CAPABILITIES AVAILABLE FOR SIMTOS RESEARCH

COMPUTER EQUIPMENT

The U. S. Army Behavior and Systems Research Laboratory (BESRL) has developed an Information Systems Laboratory (ISL) which includes a CDC-3300[1] computer system with six input/output data channels. Connected to the six input/output channels are a card reader, a punch unit, a high-speed printer, three disk pack units, two magnetic tape units, six cathode ray tube display devices, and sixteen IBM-1050[2] terminal stations. Collectively, this hardware assembly is termed the ISL computer system (Figure A-1).

Central Processor. The central processor of the ISL computer system contains 32,768 24-bit words of core storage. It is equipped with floating point arithmetic, has a cycle time of 1.25 microseconds, and is capable of performing multi-programming. In addition, it has extensive expansion capabilities; for example, core storage can be increased to 262,144 words, and the present six input/output channels can be increased to eight. Moreover, in the event the computer processing speed must be improved, additional alternatives exist: a second CDC-3300 processor could be added, or the CDC-3300 processor could be replaced by the faster CDC-3500[3] model without any software alteration.

Mass Storage. Three CDC-853 disk pack units[4] are currently available and give a combined disk storage capacity of 12,288 million characters. The disk pack units are attached to two CDC-3234 disk pack controllers each of which has the capacity of controlling eight disk pack units. Thus, there is an expansion capacity of 65.5 million characters of storage on-line without the necessity of acquiring additional control units. Two tape units are also available. Each tape has a storage capacity of 21 million characters for a combined total of 42 million characters.

Terminal Devices. Terminals of two types are attached to the ISL computer system, CDC-211 cathode ray tube (CRT) displays and IBM-1050 terminal stations. Although the two types are attached to different channels and control units, an IBM-1050 station and a CDC-211 CRT display can be co-located if desired.

The ISL has six CDC-211 display units and the capability of expanding to twelve without requiring an additional display control unit. The CDC-211 unit can display 1,000 characters (20 lines of 50 characters) and has 63 displayable character symbols. If the unit is used as a data input device, an entry marker (cursor) is visible on the CRT face to designate where a new character is to be placed. The keyboard has several

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[1] Commercial equipment and materials are identified by trade name to provide a precise description of the research procedure. Their use does not constitute indorsement or approval by BESRL or the Department of the Army.
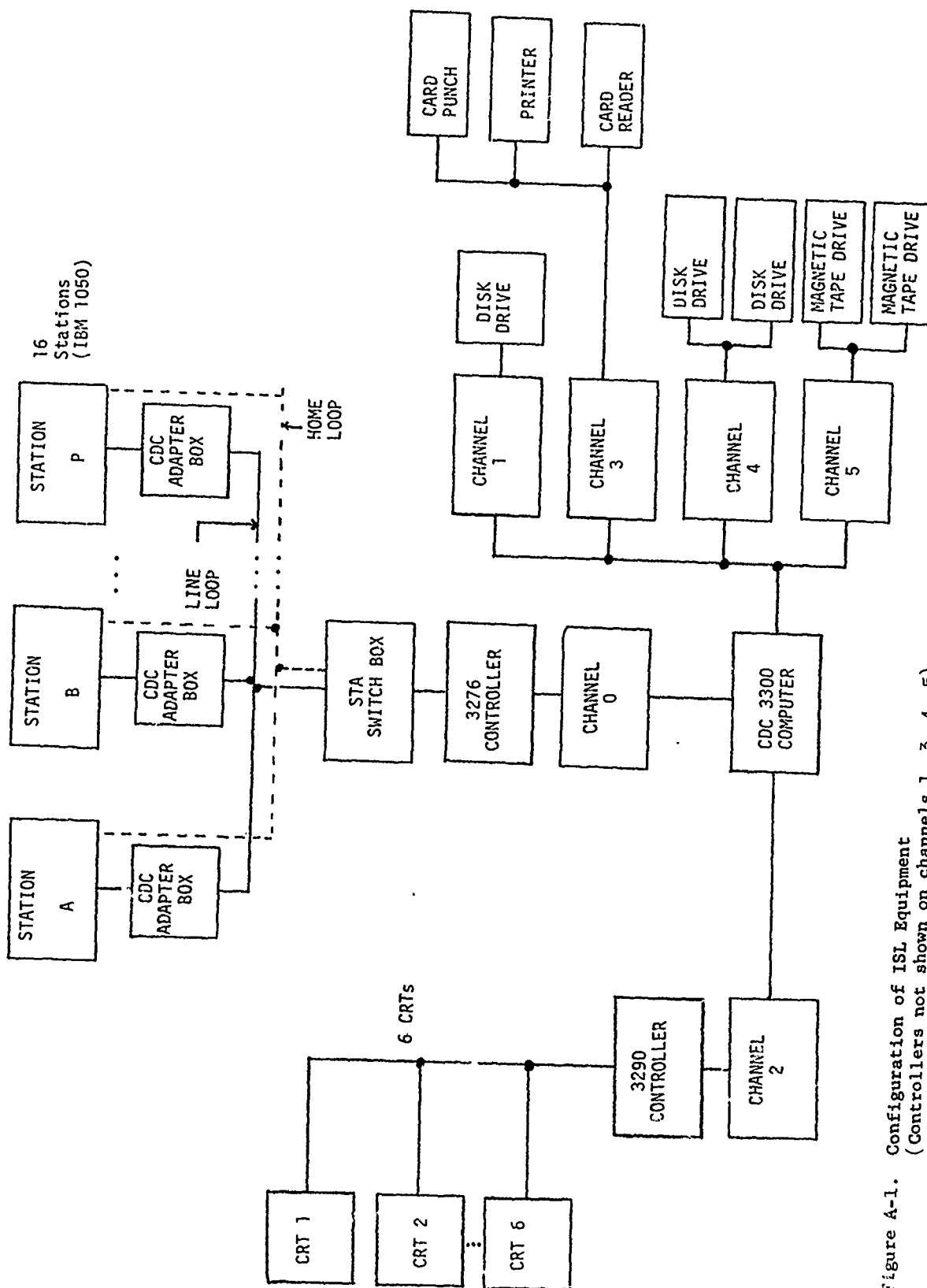
[2], [3], [4] ibid

Figure A-1. Configuration of ISL Equipment (Controllers not shown on channels 1, 3, 4, 5).

cursor positioning keys in addition to those controlling the 63 character symbols. The input/output transfer rate of the CDC-211 device is 50,000 characters per second. Data are transferred between the display unit and the computer at the discretion and control of the computer program. The computer can access the data contained on the CRT of a given device at any time.

At present, 16 IBM-1050 terminal stations can be attached on-line to the CDC-3300 computer. In addition to this linkage, a capability exists for two or more terminal stations to communicate directly with each other without utilizing the computer. This latter linkage is possible because of provision of a manually operated switching unit. Each IBM-1050 terminal station comprises an IBM-1051 control unit to which may be attached an IBM-1052 typewriter, an IBM-1054 paper tape reader, an IBM-1055 paper tape punch, an IBM-1092 programmed keyboard, and a random access slide projector (RASP). The control unit has the capability to drive motorized light tables or sets of relays to control binary (on/off) stimulus presentations.

The ISL computer facility contains a card reader with a read speed of 1200 cards per minute, a card punch operating at a speed of 100 cards per minute, and a line printer operating at a speed of 500 lines per minute.

SOFTWARE

Software packages have been developed under contract with the Control Data Corporation for the CDC-3300 system to include the FORTRAN, COBOL, and ALGOL compiler languages, an assembler language, a sort-merge package, and several operating systems and utility programs. Because the CDC-3300 is compatible with the CDC-3100, 3200, and 3500 computer systems, numerous application programs are also available. The kinds of research project that might be undertaken in a SIMTOS facility indicate that only the CDC operating system, the FORTRAN compiler, the assembler language, and certain peripheral utilities will be applicable. The FORTRAN, assembly language and peripheral utility packages are amply described elsewhere. The operating system software available in the ISL facility is discussed below.

The Operating System. The ISL utilizes the CDC Mass Storage Operating System (MSOS) to control the CDC-3300 computer. The MSOS schedules computer jobs, contains input/output routines, monitors the concurrent execution of two independent programs, and assists programmers in debugging. Although the CDC-3300 hardware is capable of allowing many independent programs to be performed concurrently, MSOS restricts the number to two, a real-time and a batched program. The ISL has allotted 6,000 words for the operating system, 16,000 words for the real-time program, and 10,000 words for the batched program. A major deficiency in MSOS is that real-time or terminal input/output operations are not performed by MSOS.

The Computer Assisted Experimentation (CAX) System. The CAX system developed for BESRL by Informatics, Inc. for use on the CDC-3300 computer is a general purpose software package which generates a testing system utilizing ISL terminal hardware. The CAX was considered for use in SIMTOS, but has been tentatively eliminated. CAX is designed to provide an automated means of administering examinations. The tester can generate numerous control cards designating equipment, messages (questions) to appear on the CRT screen, their sequence of appearance, and possible response categories. Although the CAX system is suitable for certain types of human factors experimentation, it is not likely to be required in SIMTOS oriented research. Realistic testing of tactical decision making dictates that sizable amounts of information be made available on an ad lib basis to a commander for his perusal, not as a sequence of questions and answers. CAX requires that an answer be specified on the screen by the subject in response to a question presented on the CRT. SIMTOS software will display data which can assist a subject in developing a problem solution but which does not necessarily require an immediate response. Moreover, CAX generally requires that a subject's responses can be anticipated. In SIMTOS, such requirements often cannot be met. A further consideration in regard to use of CAX in the SIMTOS is its inability to store and retrieve records from the data base in random order. This capability will be mandatory in SIMTOS.

Other Software. Although terminal input/output routines are not available with the MSOS package, BESRL has already developed most of the input/output routines required to drive the CDC-211 displays, as well as input/output routines to drive the IBM-1052 printer keyboard, the random access slide projector, the light table, and the IBM-1092 programmed keyboard. Thus, a substantial portion of the terminal input/output routine programming required for SIMTOS is now available at BESRL.

APPLICABILITY OF 7th ARMY TOS

TOS Contribution to SIMTOS. Because the 7th Army Tactical Operations System (TOS) is designed to aid command decision making and is based on a CDC-3300 system, it would seem logical to utilize TOS software to support BESRL's decision-making research. However, for a number of reasons this approach is not practicable. First, the TOS uses satellite CDC-1700 computers to interface between user input/output devices and the CDC-3300 computer. The ISL facility lacks the CDC-1700 computer. Also, the terminal typewriters used in the TOS are different from the IBM 1050 equipment at the ISL facility. Finally, the TOS utilizes five tape units; ISL has only two tape units. Thus, hardware factors prevent the use of TOS software without modification. And even if a CDC-1700 and compatible input/output devices were made available, substantial software modifications would still be required.

The SIMTOS should be highly flexible and allow changes in format size, types of data to be stored, systems to be simulated, etc. The TOS, which is designed for utilization in a field army environment, does not

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have this flexibility. In the TOS, data are generally from messages input by many users to report conditions existing in the outside world. A table generation capability is available but is oriented to a few specific files. In the SIMTOS software, a capability will be required to enable varying data bases to be developed and modified with relative ease in order to permit facile changes in scenarios and in experiment purposes. Nor does the TOS statist'cal output provide the sort of information required for BESRL experimentation. The TOS outputs are oriented toward providing data regarding software functioning--number of times a particular file is accessed, length of time a message spends in queue, etc. This information is peripheral to BESRL's major interests.

The TOS package effects computer time-sharing among many remote users; however, it does not allow the time-sharing of batch processing jobs with on-line terminal operations. Although it is not mandatory that SIMTOS software be able to perform in a time-sharing environment, incorporation of the capability would be desirable. If the TOS were used, it would have to interface with the MSOS package in order to effect time-sharing, and substantial software changes would have to be made. The entire TOS operating system would have to be revised to permit the sort of batch processing capabilities handled by MSOS.

While the considerations stated above argue against recreating an entire TOS package for BESRL's SIMTOS, it should be feasible to simulate in the SIMTOS facility many of the capabilities and operations performed by the TOS. Such a development would accelerate the ability of the laboratory to provide the Army with practical applications of research results. Many operational benefits could result from laboratory studies of TOS operations--enhanced input/output capabilities, improved displays, streamlined man-machine communication procedures, etc.

Implementation Requirements. Manpower requirements for future phases of SIMTOS software development would depend entirely on what features are incorporated and the time span desired for implementation. Although it would be premature to estimate the entire manpower level of effort to develop the ultimate version of SIMTOS software, general estimates can be given in regard to a second phase of the system. If three additional man years beyond the initial phase were expended on a second phase of SIMTOS software, the following capabilities could be part of the total system.

- From one to six subjects could be tested at any one time.

- Both the subject and the experimenter would be able to alter the data base on-line.

- Fields of separate messages could be related such that the alteration of one would affect the other.

The initial phase of SIMTOS software can be implemented on the current computer hardware available at the ISL. However, the second phase may require more computer memory than is now available. Additional memory would allow a large on-line program to reside in a time-sharing environment. Also, a possible need for additional on-line storage might introduce the requirement for an extra disk pack to be installed. Figure A-2 presents hardware acquisition requirements to support the initial research phase, operation of one control and one test room, and operation of one control and two test rooms. Because SIMTOS will operate in a time-sharing computer environment, an experienced CDC-3300 computer operator would need to be present at the computer when SIMTOS is in operation.

HARDWARE	TO SUPPORT INITIAL PHASE	TO SUPPORT ONE TEST ROOM	TO SUPPORT TWO TEST ROOMS	TOTAL
CDC-211			3	3
RASP 70 mm			3	3
SCRIPRO		3	3	6
Chart Stand	2	7	6	15
Mag Tape Deck		1		1
Audio Amplifier		1		1
TS-402 A/U		1		1
Audio Cabinet		1		1
Loudspeaker		4	3	7
Projection Screen	1	2	3	6
Field Phone		7	3	10
Switchboard		1		1
Table 2' x 5'		4	3	7
Swivel Chair	2	8	9	19
Camp Chair		4	2	6
Clock		4	3	7
Microphone		1	1	2

Figure A-2. Additional Incremental Hardware Required For SIMTOS

APPENDIX B   CONFIGURATION OF THE SIMTOS TEST FACILITY (SIMTOC)

The SIMTOS test facility is one of several users of the BESRL
CDC-3300 computer system and the only one indicated in Figure B-1. The
floor plan of Figure B-1 is based on the following constraints:

That the SIMTOC areas of the shared laboratory space not exceed
1500 square feet.

That maximum flexibility of display arrangements be obtainable
within the SIMTOC test rooms.

That the SIMTOC control station and the instrumentation area be
located close to the SIMTOC test rooms to facilitate interconnec-
tion of equipment.

The SIMTOC test facility comprises three separate areas:

1. Control Room: The SIMTOC control room, of 625 square feet,
contains test control and monitor facilities. Sufficient space is pro-
vided in this room for the addition of equipment for future expansion.
Sound proofing of this room is recommended.

2. Test Rooms: Each of the SIMTOC test rooms can contain as many
as three user input/output device (UIOD) stations in an area of 365 square
feet. The shape and area of these rooms conform generally to a staff
element's working space encountered in present field army operations.
Sound-proofing of the SIMTOC test rooms is recommended.

3. Instrumentation Area: The SIMTOC instrumentation area comprises
approximately 144 square feet. At the present time, only the data system
control panel is located here. (The control units employed for the SIMTOC
may not be located in the instrumentation area because of safety require-
ments specified in the IBM-1050 Data Communications Systems Installation
Manual. Each IBM-1051 control unit will be located in close proximity to
its associated input/output equipment.) No walls or partitions are re-
quired for the instrumentation area, nor is any special illumination re-
quired.

SIMTOC TEST ROOMS

Figure B-2 shows a floor plan for one of the SIMTOC test rooms
divided into three subject stations. Each room can be used separately
to test three officers, for example, each operating at a different level.
Alternatively, two or more of the UIOD stations could simulate stations
at different staff levels. Figure B-3 shows one possible equipment con-
figuration of a single subject station; different arrangements can be
provided. Figure B-4 presents a list of equipment for one test room
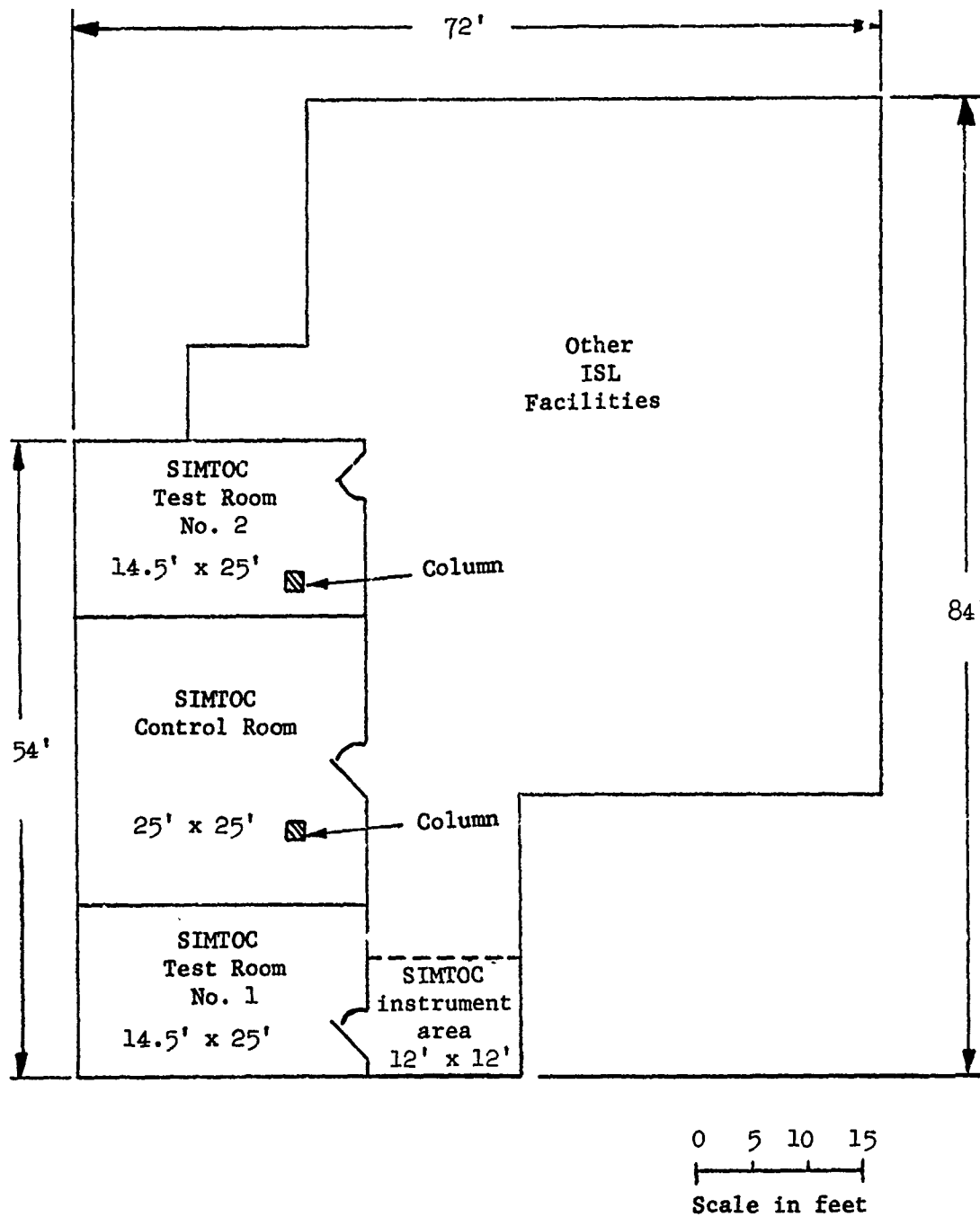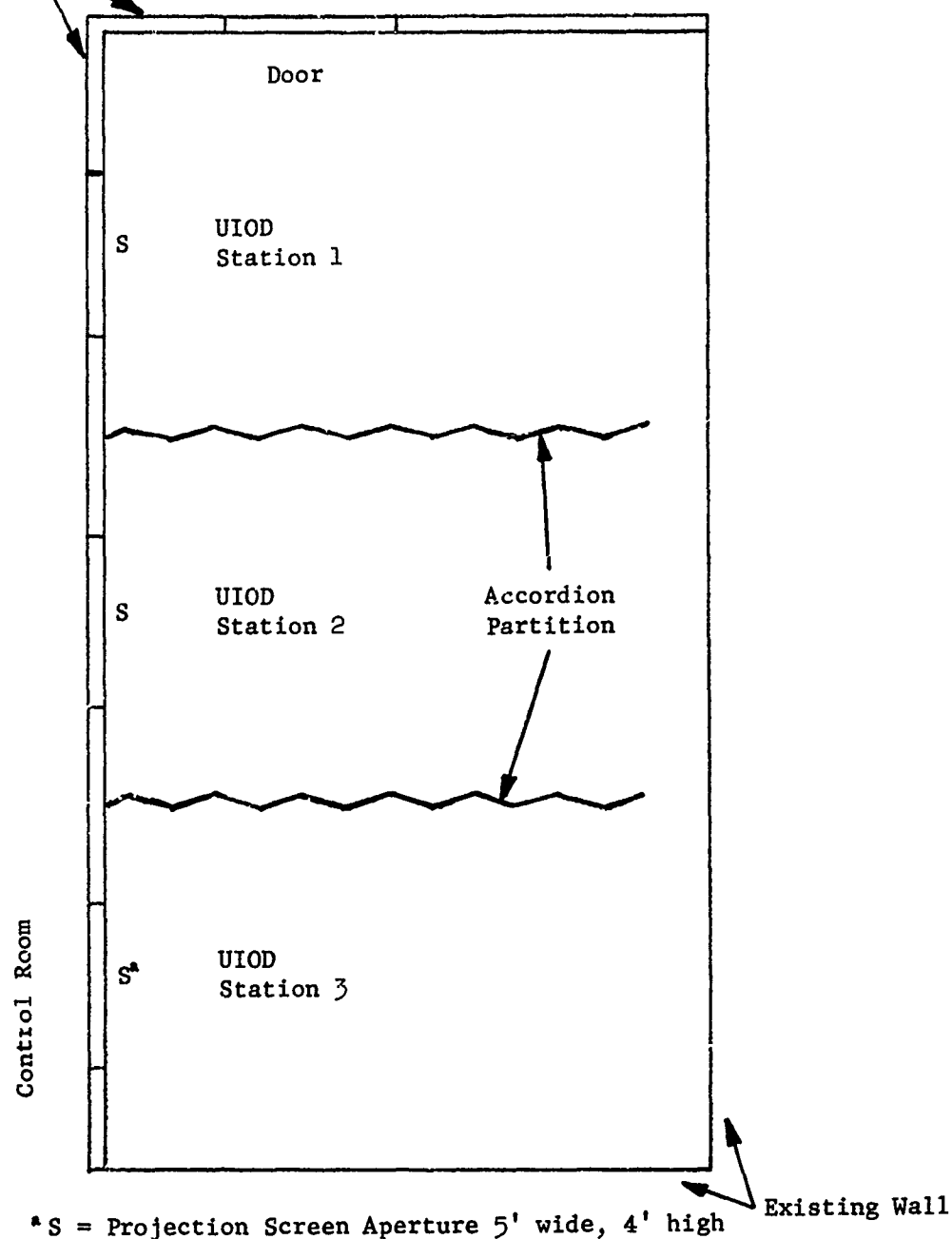(three subject stations).

Figure B-1. Allocation of floor space in SIMTOC test facility

Sound-Insulating Partition   Instrument Area

* S = Projection Screen Aperture 5' wide, 4' high

0 1 2 3 4

Scale in feet

Figure B-2.   Floor plan for SIMTOC test room No. 1

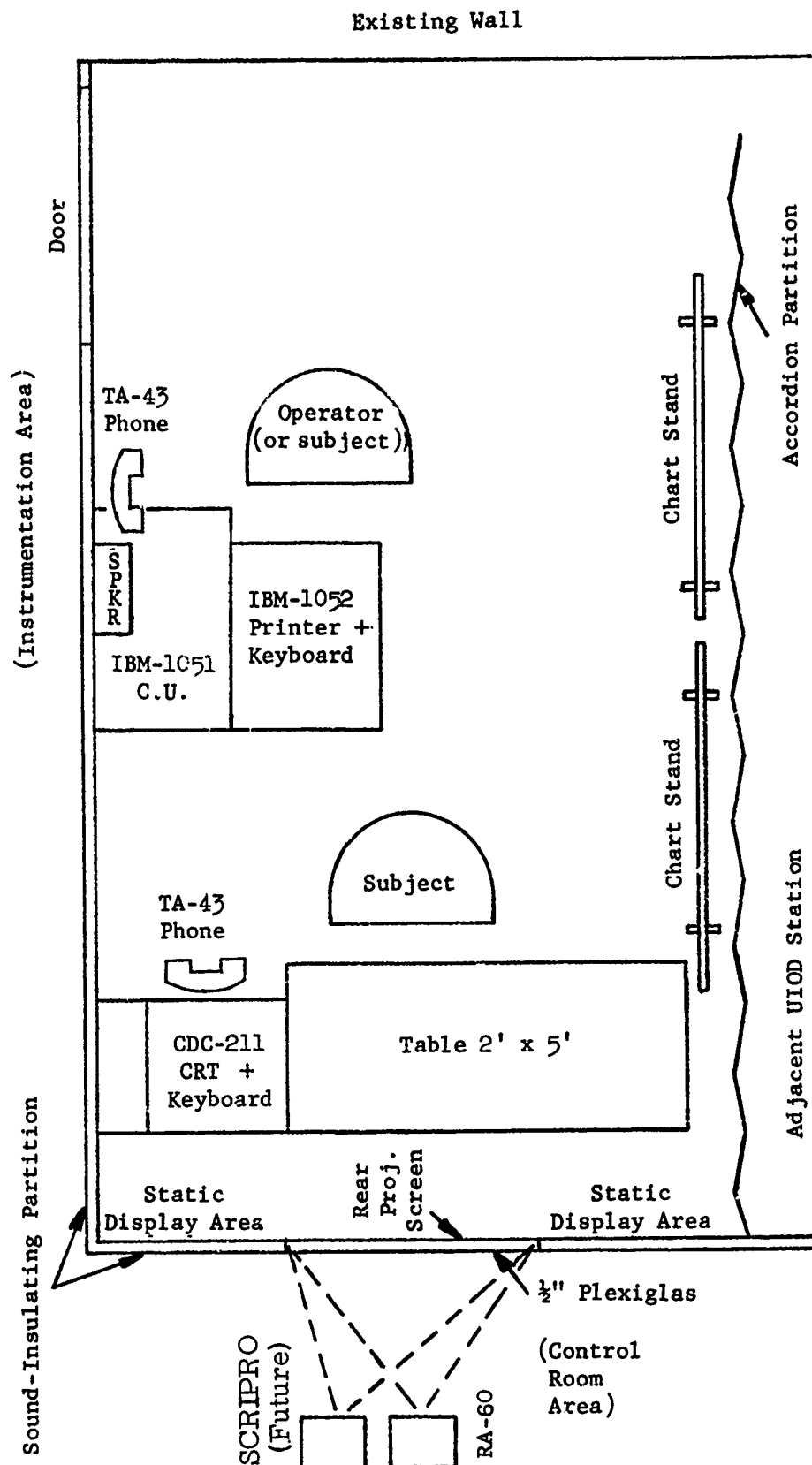Figure B-3. Floor plan for one UIOD station of test room No. 1

QUANTITY	ITEM	FUNCTION	STATUS
3	IBM-1052 printer and keyboard	Slow-speed user input/output device providing hard copy and TTY communication between stations.	Available at BESRL
3	IBM-1051 control unit (a necessary part of IBM-1052 above)	Functions as utility table.	Available at BESRL
3	CDC-211 cathode ray tube (CRT) display and keyboard	High speed user input/output device. May also be used for communication stations.	Available at BESRL
3	Table 2 ft. by 5 ft.	General utility.	Required. To be fabricated locally.
6	Swivel chair with support back	3 for test subjects and 3 for operators.	Required. Obtain from GFE or by local purchase.
6	Portable chart stands 4' by 6'	General utility.	Required. To be locally fabricated.
6	Field telephone TA-43 or equal	For voice communication between stations	Available at BESRL
3	Loudspeaker, LS-56 or equal	To provide environmental noise.	Required. Obtain from GFE.
3	Electric wall clocks	Time.	Required. Obtain from GFE.

Figure B-4. List of equipment in SIMTOC test room

No attempt will be made at present to alter temperature or humidity of the working environment during the tests. A normal office climate and ventilation as provided by the BESRL building is assumed. Care must be taken, however, to assure ducting into each test station area and one exhaust duct from each test room. Thus, there may be three input ducts to a test room. These will be necessary for adequate ventilation if the accordion partitions are used to form test cubicles.

Overall sound reduction of the SIMTOC test rooms will be obtained by installing perforated acoustic tile on all walls and the ceiling. Walls will be equivalent to dry-wall construction six inches thick. Projector screen openings should be soundproofed by installing a clear Plexiglas plate[1], ¼ inch thick, on the control room side of each opening. [Although the projectors are noiseless, the control room personnel are not.]

Noise speakers will provide acoustic noise obtained from pre-recorded magnetic tape and should be controlled automatically by the computer program or manually by the test director. Speakers will be mounted on the wall at maximum height and located as shown in Figure B-3.

Illuminance on a horizontal surface 30 inches above the floor should be provided by indirect ceiling fixtures and should be not less than 30 foot candles at any location in the room. The illuminance should be continuously variable from 30 foot candles to zero by means of a manual control.

Three apertures (60" x 48") for rear projection screens will be provided as indicated in Figure B-3. These apertures will be centered at 60 inches above the floor. The apertures will be finished in the same manner as door frames. A door will be provided as shown in Figure B-2. Access to adjacent stations in the test room is accomplished by folding the movable partitions.

SIMTOC CONTROL ROOM

The control room floor plan (Figure B-5) shows the equipment configuration and indicates the position of test director and control operator. Figure B-6 describes the equipment in more detail. From one to three control operators can be used. The No. 1 control operator position is the master control position and has, in addition to the low-speed (IBM-1052) and high-speed (CDC-211) input/output terminals common to all control operators, an IBM-1054/55 paper tape reader and punch, a telephone switchboard SB-22, and control of the acoustic noise distribution to the SIMTOC test rooms. For tests which require only a single control operator, the No. 1 control operator position is used.

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[1] See footnote 1, Appendix A, page 23.

Figure B-5. Control room plan

The audio cabinet shown in Figure B-5 is a standard relay rack cabinet housing the audio tape reproducer, the audio amplifier (TS-402) attenuators, and LS-66 monitor speaker for the acoustic noise distribution system.

The random access slide projectors located physically in the control room provide slide displays to the test subjects in the adjacent SIMTOC test rooms. Control of the displays is by means of a computer program or by a control operator activated automated sequence via the IBM-1092 programmed keyboard. The projector digital control unit is the digital-to-analog converter for automation of the projectors. Each control operator can also operate a display by means of the projector manual control located on his IBM-1051 cabinet. Control operators may monitor the displays presented on the SIMTOC test room screen, though the screen image will of course be viewed in reverse. Space is available for the addition of three to six scribing projectors and associated equipment when these become available (see Equipment List, Figure B-6).

Soundproofing is desirable. All walls and the ceiling of this room will be covered with acoustic tile. Screen apertures should be double Plexiglas[a] (one clear, one Polacote). Walls will be equivalent to insulated dry-wall construction 6 inches or more thick.

Illuminance on a horizontal surface 30 inches above the floor will be provided by indirect ceiling fixtures and will be not less than 30 foot candles at any location in the room. There is no requirement for variation of the light intensity.

Illuminated map areas will be provided on the wall as shown in Figure B-5. Each area is approximately 6' by 6'. When the general illumination of the room is turned off, the illuminated map areas will each be provided with a uniform minimum illuminance of 30 foot candles. Light will be incident to the map surface at an angle of 60 degrees, or less, to reduce glare, and light distribution will be generally limited to the map area. If fluorescent lighting is used, it will be of quasi-daylight quality and of the minimum flicker type.

A door and rear projection screen apertures will be provided as shown in Figure B-5. Each projection screen aperture will be centered at 60" above the floor and will be finished similarly to the door frame. The rear projection screens should be ¼" Polacote mounted in the test rooms with the smooth side toward the test room. On the control room side of the partition, a clear plexiglas ¼" panel should be mounted, creating at least a 3" dead-air space to reduce voice sounds emanating from the control room during testing and also to protect the Polacote surface. The plexiglas panel should be removable, by means of screws, when it is necessary to improve resolution on the Polacote screen.

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[a] See footnote 1, Appendix A, page 23.

QUANTITY	ITEM	FUNCTION	STATUS
3	IBM-1052 printer and keyboard	Slow-speed input/output device for use with computer and for TTY communication with UIOD stations in SIMTOC test room.	Available at BESRL
3	IBM-1051 control unit (a necessary part of IBM-1052 thru 1092.)	Functions as a utility table.	Available at BESRL
3	IBM-1092 programmed keyboard.	Slow-speed input device to transmit pre-set numeric data to the computer and to control the random access slide projectors by means of pre-set numeric instructions.	Available at BESRL
1	IBM-1054 paper tape reader.	Slow-speed input device to transmit data from perforated paper tape to the computer or to UIOD stations; or to prepare a hardcopy on the 1052 printer.	Available at BESRL
1	IBM-1055 paper tape punch.	Slow-speed output device. Produces a punched paper type from an incoming message or from the local 1052 keyboard.	Available at BESRL
3	RA-60 random access slide projector (RASP) for 70 mm slides.	To display slides to UIOD stations.	Available at BESRL

Figure B-6. List of equipment in the SIMTOC control room (for one test room)

QUANTITY	ITEM	FUNCTION	STATUS
3[a]	Projector digital control (PDC) units.	To provide interface with the IBM-1051 for automatic slide selection of the RASP by means of the IBM-1092 keyboard or from the computer program.	Available at BESRL
3[a]	Projector manual control box (PMC)	For control operator use in selecting slides manually.	Available at BESRL
3[a]	Scribing projector (not shown on Figure 4; will be installed adjacent to each RASP)	Provides on-line overlay to the RASP display by computer program or by manual control from a UIOD station.	Not available. Grease pencil overlays may be used until these projectors are made available.
3[a]	CDC-211 CRT display and keyboard	High-speed input/output device for use with the computer or for communication with other stations.	Available at BESRL
1	Telephone switchboard SB-22 or equal.	Provides manual switching for field telephones of the control and test rooms.	Required. Obtain from GFE.
4	Field telephone, TA-43 or equal.	Provides voice communication between control stations and test stations.	Required. Obtain from GFE.

[a]Three additional are required if second test room is added.

Figure B-6 (continued)

QUANTITY	ITEM	FUNCTION	STATUS
1	Auxiliary table, IBM, 32" wide, 23" deep, 27" high.	For installing IBM-1054 paper tape reader and IBM-1055 paper tape punch.	Available at BESRL
2	Magnetic tape reproducer for 1/4" tape on 7" reels, speeds 3 3/4 and 7 1/2 ips with preamplifier providing 0.5 V signal + 3 db., 100 Hz to 10 kHz into 600 ohm load; for operation on 115 volts, 60 Hz and for mounting in a 19" rack (or table operation).	For the reproduction of pre-recorded noise tapes typical of field army TOC environment. One to be mounted in audio cabinet described below. The second machine to be employed to record, as desired, verbal communications between selected stations or to record monitored communications within a test room.	Required. Obtain from GFE or by local purchase.
1	Audio amplifier, single channel, 10 watts undistorted output; bandwidth 100 to 10,000 Hz; 600 ohm input and output; maximum gain 80 db or greater, for operation on 115 volts, 60 Hz.	For the amplification of pre-recorded noise tapes, see above. To be mounted in audio cabinet described below.	Required. Obtain from GFE or by local purchase.
4ᵃ	TS-402 A/U or equal, attenuator, 600 ohm input and output.	For controlling the intensity of reproduced noise. To be mounted in the audio cabinet described below.	Required. Obtain from GFE or by local purchase.

ᵃThree additional are required if second test room is added.

Figure B-6 (continued)

QUANTITY	ITEM	FUNCTION	STATUS
1	Loudspeaker LS-66 or equal	For monitoring acoustic noise by the control operator. To be mounted on the audio cabinet described below.	Required. Obtain from GFE or by local purchase.
1	Audio cabinet, steel, for standard rack mounting of 19" panels. Dimensions: 20" wide, 22" deep, 48" high. Premier Metal Products DCR,[b] or equal.	For installing components of the acoustical noise reproduction system.	Required. Obtain from GFE or by local purchase.
1	Table, 2' by 5', 31" high.	General utility.	Required. To be locally fabricated or obtained from GFE.
4	Swivel chair with support back.	1 for test director and 3 for control operators.	Required. Obtain from GFE or by local purchase.
3	Portable chart stands, plywood, 6' wide x 6' high.	General utility for chart display.	Required. To be locally fabricated.
4	Folding camp chairs.	Chairs for assistants (as required).	Obtain from GFE.
1	Wall clock	Common timer for testing.	Required. Obtain from GFE or by local purchase.

[b] See footnote 1, Appendix A, page 23.

Figure B-6 (continued)

SIMTOS COMMUNICATIONS

Slow-speed Data Communication. Slow-speed data communication is accomplished with the IBM-1052 printer-keyboard in the half-duplex mode of operation at a data rate of approximately 15 characters per second. Figure B-7 shows the input/output and communications schematic diagram. The data system control panel provides a total of 16 station switches; six of these switches are required for slow-speed data communication between the control room and one test room. The remaining switches are available for other functions, including operation of a second test room if desired. The data system control panel can be used for manual switch selection of the following communications modes for SIMTOS slow-speed digital data:

- Any or all of the test stations or control stations can communicate on-line with the CDC-3300 computer by setting the corresponding switches to the computer position.

- Two or more stations can communicate with each other via a common switch-selected data communications line, thus simulating Army teletype communication between stations.

- Two or more stations can communicate with each other on one data communications line while another pair of stations uses a different line for data communication, thus simulating independent teletype systems.

- Any or all stations can be isolated from the computer or from the communications lines in order to permit "home" operations of station equipment or to simulate computer or communication dropout.

High-speed Data Communication. The CDC-211 cathode ray tube display with keyboard provides half-duplex data communication at a rate of 50,000 characters per second. As shown in Figure B-7, one CRT display is provided for each test subject and each control station. (When two test rooms are in operation, each control station will have two CRT display units.) The CRT provides for communication with the computer or with the CRT at another station. Communications routing is determined by the CDC-3290C display controller and is under program control. All CRT display units are connected directly to the CDC-3290C display controller. A CRT display message can, if desired, be converted to a hard-copy record by the IBM-1052 printer at any station, but only at the slow-speed (15 characters per second) data rate.

Data Communication Error Rates. Random digital data errors similar to those caused by interference and noisy communications circuits can be provided for both low-speed and high-speed SIMTOS data communications by means of the computer program. Various degrees of circuit degradation can, if desired, be simulated to determine effects on subject performance. Time intervals for the introduction of this degradation will also be under program control.
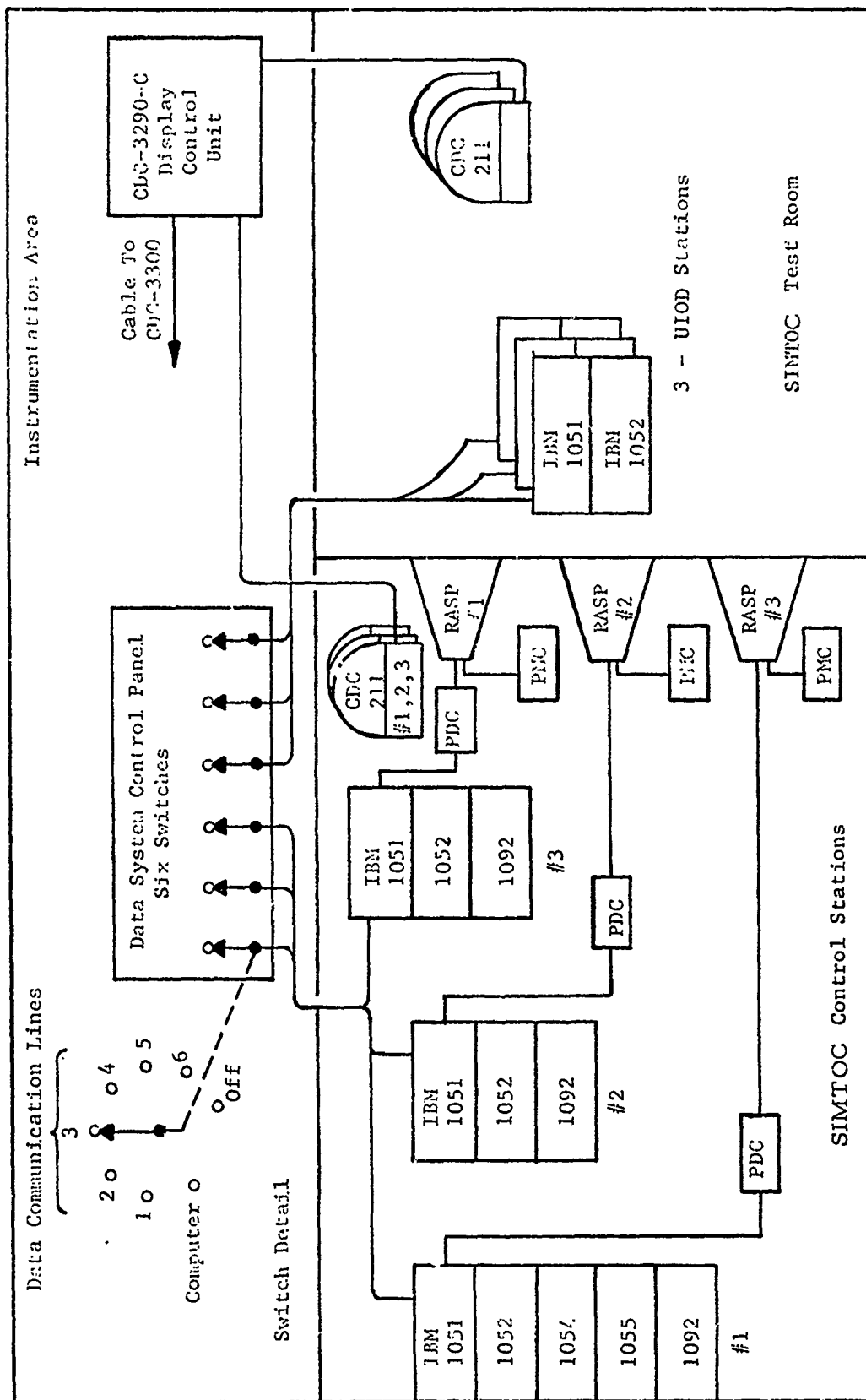
Figure B-7. SIMTOC input/output and data communications

Voice Communication. As shown in Figure B-8, field telephones
TA-43 are used for voice communication between all stations. An SB-22
manual switchboard is located in the SIMTOC control room.

Acoustical Noise. A controlled acoustical noise ambient is pro-
vided to the test rooms. The purpose of this is to introduce an element
of realism to the test environment and to aid in masking sounds from
nearby test areas. As shown in Figure B-8, noise is reproduced from
pre-recorded audio tapes, amplified, monitored, and controlled at the
control room and distributed to the test rooms. When the BESRL com-
puter-activated relay system becomes available, the introduction of
noise can be controlled automatically by the computer. Realistic
audio tapes can conveniently be obtained from recordings made within
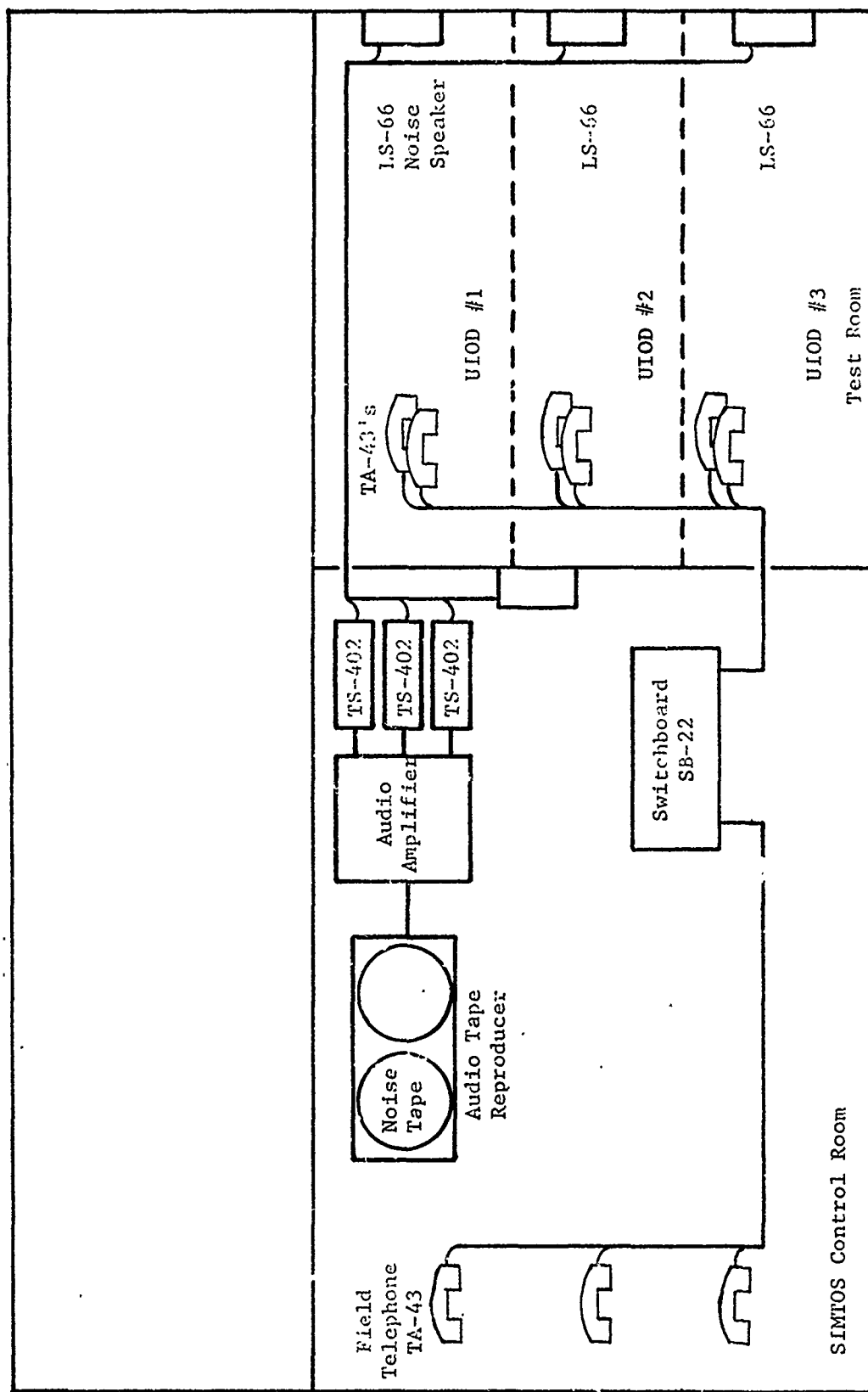TOCs during Seventh Army command post or field training exercises.

Figure B-8. Telephones and acoustic noise system